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Title: Method for metallizing a component comprising parts of different non-metallic materials

#### FIELD OF THE INVENTION

- 5    The present invention relates to a method for metallizing a component that comprises a first part, constituted by a first non-metallic material, and a second part, constituted by a second non-metallic material.

#### BACKGROUND OF THE INVENTION

- 10    Known methods for metallizing non-metallic components (consisting either one or more component parts) may comprise the following steps:
- etching the component's surface to get a roughened and hydrophilic surface for good bonding properties;
  - surface sensitization, e.g. by adsorption of Sn ions to the surface;
  - 15    - surface activation, e.g. by reduction of Pd ions to metallic Pd by means of said Sn ions, resulting in a metallizing base layer or seed layer (hereinafter called "seed layer") that is catalytic to the subsequent chemical metallization process ;
  - metallizing and formation of a metal coating on the Pd seed layer by means of catalytic reduction of metal ions (e.g. Cu or Ni) from a solution that comprises both the
  - 20    relevant coating metal ions and a reduction chemical.

Components may comprise two or more component parts made from different materials. Such multi-material components may be fit for selective or partial metallizing. Several different methods for selective metallization are known, like selective surface

25    conditioning (a), the use of pre-catalyzed polymers (b), laser activation (c) or lithographic techniques etc. (d).

(a) Selective surface conditioning: parts consisting of different materials are given a surface treatment using a solution for which the one part material does and the material of the other part does not show a strong adsorption behaviour (e.g. by using a specific

30    combination of etching and sensitization as mentioned above). However, this method, using a "discriminating adsorbent", only works in very limited cases with 100%

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selectivity (discrimination). Almost always there is some metal deposition upon the component part that is not to be metallized. Especially in micro-applications this may be very critical and may lead to e.g. errors in electric circuits.

(b) Pre-catalyzed polymers are polymers of which the grain already contains compounds catalytic to the chemical metallization process, e.g. Pd particles or salts, which are used to build a metallizing seed layer. By using one component part made of a pre-catalyzed polymer and another one made of a not pre-catalyzed polymer, only the pre-catalyzed polymer component part will be metallized, while the other one will remain not-metallized. A drawback of this known method is the relative high price of the base material and the unfavourable influence on the characteristics of the relevant polymer.

(c) By using polymers containing substances that can be converted by photonic energy, e.g. by exposure to laser light, into catalytically active compounds for the chemical metallization process. In this way a pattern can be created on the surface. Only the parts exposed by the light will initiate chemical metallization. Also here a serious drawback is that the relevant additives have a negative effect on the polymer's characteristics.

(d) Selective metallizing may alternatively be performed by means of masks upon the component's surface. In most cases the components are metallized completely, after which the desired pattern is etched via a lithographic mask.

## 20 SUMMARY OF THE INVENTION

The present invention is based on the use of different chemical solubility or resistance of different (e.g. polymeric or ceramic) materials. The method comprises the metallizing of a component that is constituted by a first part, made of a first material, and a second part, made of a second material. According to the inventive method a metallizing seed layer, which may be catalytic to the further metallization process, is applied at the surface of said component or a relevant part of that component's surface, after which the surface of the whole component or at least the relevant part of it, including said seed layer, is exposed to a "discriminating" solvent in which the surface material of said first part is soluble but the surface material of said second part is not. The first material may be a first polymer or other plastic, the second material a second polymer or plastic. Also other kinds of non-conductors, like e.g. ceramics, may be applied as first and/or second

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material.

After the surface has been exposed to a solvent in which the first part is and the second part is not soluble, the first part's surface, including its seed layer, will be solved in the solvent and eliminated. The metallizing seed layer thus will only stay at the surface of the second component part, which was made of a material, not soluble in (well resistant to) the used solvent. After a subsequent exposure of the (complete) component to a metallizing environment, only that component part, the second part, on which the metallizing seed layer was left after exposure of the "discriminating" solvent, will be metallized, due to the presence of the remaining seed layer at the second component part and the absence of it at the first part.

## FIGURES

Figures 1a-g illustrate schematically the metallizing process of a component with two parts made of different materials.

Figure 1a shows a component, consisting a first component part 1, made of a first material e.g. polymer, and a second component part 2, made of a second material e.g. polymer.

Figure 1b illustrates that the whole component is exposed to an activating or etching environment 3 (e.g. an etching bath) to get a hydrophilic and roughened surface 4 for good bonding properties.

Figure 1c shows that the component surface 4 is -in a processing environment 5- "sensitized" for metallizing, e.g. by adsorption of Sn ions to the surface and subsequent activation, e.g. by reduction of Pd ions to metallic Pd by means of said Sn ions, resulting in a metallizing seed layer 6.

Figure 1d shows that, subsequently, the surface of the component, including the seed layer 6, is exposed to a solvent 7, in which the surface of said first component part 1 is

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soluble but the surface of the second component part 2 is not. The surface of component part 1, including the seed layer 6 upon it, will thus be solved in (or etched by) the solvent 7 after which the residue can be removed.

- 5 Figure 1e shows that the metallizing seed layer 6 only stays at the surface of the second component part 2, represented by a partial seed layer 8.

Figure 1f shows that, after exposure of the (whole) component to a metallizing environment 9, only component part 2, covered by the partial seed layer 8, will be  
10 metallized -represented by metal layer 10- due to the absence of the seed layer at the first component part 1 and the presence of it at part 2. The metallizing environment 9 may be based on of catalytic reduction of a metal coating (e.g. Cu or Ni) applied upon the seed layer 8 from a solution comprising both the relevant coating metal ions and a reduction chemical.

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The result of the final metallizing process, represented by figure 1g, is a two-part component, of which only one part, viz. part 2, is covered by metal layer 10, while the other part, part 1, remains un-covered, due to the absence of the metallizing seed layer 6, which was solved by the "discriminating" solvent 7 (figure 1d).

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There are lots of solvents known in which different plastics show different solubilities and which will thus be fit for the process of figure 1d, for example (source:  
[http://www.kimble-kontes.com/pdfs/solvent\\_compatibility\\_2.pdf](http://www.kimble-kontes.com/pdfs/solvent_compatibility_2.pdf)):

Abbreviation	Chemical Designation
ABS	Acryl-Butadienestyrene
	Acetal (Delrin <sup>®</sup> , Celcon <sup>®</sup> )
LDPE	Low Density Polyethylene
HDPE	High Density Polyethylene
NYL	Polyamide (Nylon <sup>®</sup> )
PCTFE	Polychlorotrifluoroethylene (Kel-F <sup>®</sup> )
PC	Polycarbonate
PP	Polypropylene
PTFE	Polytetrafluoroethylene (Teflon <sup>®</sup> )
PVC	Polyvinyl Chloride
PVDF	Kynar (polyvinylidene fluoride)
E-CTFE	Ethylene Chlorotrifluoroethylene
ETFE	Ethylene Tetrafluoroethylene (Tefzel <sup>®</sup> )
PFA	Perfluoroalkoxy (Teflon <sup>®</sup> )
San	Styrene
PMP	Polymethylpentene (TPX)
PMMA	Polymethylmethacrylate (PMMP)
PS	Polystyrene
PEEK	Polyetheretherketone
TFE	Tetrafluoroethylene (Teflon <sup>®</sup> )

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A = NO EFFECT, EXCELLENT	PLASTIC RESIN MATERIAL																	
B = MINOR EFFECT, GOOD																		
C = MODERATE EFFECT, FAIR																		
D = SEVERE EFFECT, NOT RECOMMENDED																		
SOLVENT	ABS	Acetal	ECTFE	ETFE	HDPE	LDPE	NYL	PC	PCTFE	PEEK	PMP (TPX)	PP	PTFE	PVC	PMMP	PS	SAN	TFE
Acetaldehyde	D	A	A	A	B	C	C	C	A	A	C	C	A	D	D	D	D	A
Acetic Anhydride	C	D	A	A	D	D	C	D	A	A	B	B	A	D	D	D	D	A
Acetone	D	D	A	B	C	C	B	D	A	A	A	A	A	D		D	D	A
Acid, Hydrofluoric	C	D	A	A	A	A	D	D	A	A	A	B	A	B	D	D	C	A
Acid, Trifluoroacetic	D	C	C	C	C	D	D	D	A	A	D	D	A	D	D	D	D	A
Acid, Acetic Dilute 50%	A	C	B	B	A	A	D	B	A	A	A	A	A	B	D	B	D	A
Acid, Hydrochloric 37%	C	D	A	A	A	A	D	D	A	A	B	B	A	B	A	C	C	A
Acid, Nitric	B	D	A	A	B	C	D	B	A	A	A	B	A	B	C	C	C	A
Acid, Sulfuric	D	D	A	A	A	B	D	C	A	A	B	C	A	B	D	C	D	A
Acetonitrile	D	D	A	A	A	A	A	D		A	C	C	A	D		D	C	A
Alcohol, Ethyl	A	D	A	A	A	B	D	B	A	A	B	B	A	B	B	B	C	A
Alcohol, Isobutyl	A	A	A	A	A	A	D	B	A	A	A	A	A	B	B	B		A
Alcohol, Methyl	D	B	A	A	A	A	D	B		A	A	A	A	B	D	C	C	A
Alcohol, n-Butyl	A	A	A	A	A	A	D	C	A	A	B	A	A	A	B	B	B	A
Alcohol, Propyl	B	A	A	A	A	A	D	D	A	A		A	A	A		A		A
Ammonium Hydroxide	B	A	A	A	A	A	C		A	A	B	B	A	B	C	B	D	A
Aniline	D	B	A	A	B	B	B	B	A	A	B	B	A	B	D	D	D	A
Aqua Regia	D	D	B	C	C	D	D	D	A	A	D	D	A	C		D		A
Benzaldehyde	B	A	B	B	A	B	B	C	A		B	A	A	D		D	D	A
Benzene	D	A	B	B	D	D	A	D	B	A	B	B	D	A		D	D	A
Carbon Tetrachloride	D	B	A	A	C	B	A	D	A	A	D	B	A	B	D	D	D	A
Caustic Soda (NaOH)	B	B	A	A	A	B	B	D	A	A	A	A	A	D	D	A	D	A
Chlorobenzene	D	D	B	B	C	D	B	D	A	A	C	D	A	D		D		A
Chloroform	D	B	B	B	C	C	D	D	B	A	D	B	A	C		D	D	A
Cyclohexane	A	A	B	B	C	C	A	D	A	A	D	C	A	D	D	D		A
Esters	D	D	A	A	B	B	A	D	B	A	B	B	A	C		D		A
Ether	D	A	B	B	C	D	A	C	B	A	D	D	A	D		D	D	A
Ether, Diethyl	D	D	B	B	D	A	C	D	C	A	D	D	A	D	C	D	D	A
Ether, Isopropyl	B	A	A	A	A	A	B	A	A	A	A	D	A	A	A	A	A	A
Ethyl, Methyl	D	B	A	A	B	A	B	D	A	A	D	B	A	D	D	D	D	A
Hexane	D	B	A	A	B	D	A	C	A	A	C	B	A	C	C	D	A	A
Hydrazine	B	B	A	A				D	B	A	D	C	A	C	D	D		A
Hydrogen Peroxide	B	B	A	A	A	D	B	A	A	A	A	A	A	A	A	B		A
Methylene Chloride	D	B	A	A	C	D	A	D	A	D	C	C	A	D	C	D	D	A
Petroleum Ether	B	A	A	A	A	B	A	A		A		A	A	B	D	B		A
Phenol	D	C	A	A	D	D	D	D	A	A	D	D	A	C	D	C	D	A
Sodium Hydroxide	B	D	A	A	A	B	B	D	A	A	A	B	A	B	D	A	C	A
Tetrahydrofuran	D	A	A	A	B	C	A	D	A	D	C	B	A	D	D	D	D	A
Toluene	D	B	A	A	B	C	C	D	A	A	C	C	A	D	D	D		A
Trichloroethylene	D	B	B	B	C	D	B	D	A		A	D	D	A	D	D	D	A
Trimethylpentane,2,2,4	D	C	B	B	C	C	A	D		A	C	C	A	D	D	D	D	A
Water	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Xylene	D	A	A	A	C	D	A	D	A	A	C	C	A	D	D	D	D	A

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As an example, experimented by the applicant in practice, a component may comprise the first part 1 made of PC and the second part 2 of ABS. Using, in the step as depicted in figure 1d, a 400 g/l sodium hydroxide (NaOH) solution as discriminating solvent 7, for which solvent ABS is well resistant (class B in the above table) and PC is not-  
5 resistant (class D in the table), resulted in a nearly 100% selective metallizing of the ABS component part 2 with a metallic (Cu) layer 10, covering the previously produced seed layer 8, while the PC component part 1 remained uncovered.

In general, pointing to the above solvents resistance table, a combination of different  
10 materials and a solvent has to be chosen for component parts 1 and 2 respectively, for which the material of part 1 has a low resistance (class D) for the relevant solvent, and part 2 a excellent or good resistance (class A or B). Besides, there are requirements to e.g. the moulding characteristics etc.

Further, it is noted that the present inventive method, using a "discriminating solvent", solving and/or etching the surface of the component part that has a low resistance to the relevant solvent, may be used in combination with the known method, referred in the paragraph "Background of the invention" under section (a) "Selective surface conditioning", using a "discriminating adsorbent" that has different (adsorption)  
15 properties for the different materials of which the parts 1 and 2 are made. Both, use of the known "discriminating adsorbent" (figure 1c) and the inventive "discriminating solvent" (figure 1d) may enforce each other, thus enhancing the final result.

Finally, for good order, the known method, using a "discriminating adsorbent" has to do  
25 with the forming of the metallizing seed layer 6. The aim of said known method is to produce a seed layer 6 only at the surface of e.g. the component part 2. As said before, the results of this known method are rather poor and only works satisfactory in a very limited number of combinations of materials: in practice also at the surface of component part 1 a seed layer 6 will be formed more or less. The inventive method,  
30 using a "discriminating" solvent" has to do with selective etching away the previously formed seed layer 6, using a solvent or etching medium to which only the material of

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part 1 is not resistant, thus etching away (only) the surface of part 1, together with its metallizing seed layer 6.